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The Liquid Sodium Dynamo Experiment, NMTech and LANL[1]

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The liquid sodium $\alpha\omega$ dynamo experiment is designed to demonstrate how magnetic fields are generated in AGN and stars. Naturally occurring large scale astrophysical flows, Keplerian flow and star-disk driven plumes or scale-height buoyant plumes in stars create large scale $\alpha\omega$ dynamos where diffusive transport of magnetic flux by turbulence is much less than the advected magnetic flux, thus constraining turbulent diffusion, a common problem with Dudley James type flow experiments. The constraint on turbulence is the gradient of angular momentum in stable Couette flow in the experiment, the anologue of Keplerian flow or entropy gradient in stars. The experiment consists of two coaxial cylinders, $r_1 = 15$ cm, $r_2 = 30$ cm, $\Omega_1/\Omega_2 = 4$ i.e., limiting stable Couette flow. We expect an ω-gain of the toroidal field of $Rm/2\pi = 20$. The MRI will be tested at a sensitivity of $\Delta B/B \sim 10^{-3}$. The α gain is driven by off-axis, axial plumes as in convection in a rotating frame. Because of the high ω gain, the turbulence generated by the plumes should be fractionally small. The apparatus has been built and tested with hot oil and water in the laboratory and we have measured, in agreement with theory, the low turbulence expected of stable Couette flow at the level of the Ekman flow.

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